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Presented at the 1981 Research Forum on Children and Youth, this report describes the nature and impact of the most important dental health problems that affect children and youth in our society, summarizes the advances achieved by research during the last decade, and identifies those areas where research is required for continued progress over the next decade. (Author/MP)

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MATRIX NO. 12

DENTAL DISEASES OF CHILDREN AND YOUTH

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DENTAL DISEASES OF CHILDREN AND YOUTH

Introduction

Oral diseases and conditions affecting children include dental caries, malocclusion of the teeth and jaws, cleft lip and/or palate, traumatic injuries to the mouth and face, periodontal diseases, and oral ulcerations. This complex of maladies constitutes a significant health problem among the children of this country. These diseases may not only be detrimental physically, but may also affect the mental well-being of an individual. Disfiguring dental and facial conditions all too frequently have a devastating effect on self-esteem and thereby inhibit social development and limit life opportunities. It should be recognized that the oral health status of the adult almost wholly is determined by childhood experiences. A child with a high caries rate, for example, is likely as an adult to continue to need extensive treatment to restore teeth damaged by both childhood and adult caries. If not properly treated during childhood, severe malocclusion and other congenital and developmental oral anomalies may cause lifetime disfigurement, precipitate psychological problems and otherwise adversely affect the quality of life. Similarly, a child who does not learn proper oral hygiene practices is likely to experience destructive periodontal disease in adulthood, just as those who start smoking are likely to develop oral or lung cancer later in life. Therefore, comprehensive programs of health education must be developed so that children and their parents will become aware of the long-term benefits of the prevention and prompt treatment of oral disease. In addition, if we are to continue to develop and implement effective, low-cost solutions to these widespread problems, it is essential that appropriate research programs be maintained.

The present report describes the nature and impact of the most important dental health problems that affect children and youth in our society, summarizes the advances achieved by research during the last decade, and identifies those areas where research is required for continued progress over the next decade.

Dental Caries

Dental caries or tooth decay is the most prevalent disease of children, ultimately affecting over 95% of the population over 12 years of age. It usually strikes early in life and continues at an accelerating rate through childhood and the teenage years. In the United States, children 3 years of age have caries in more than one primary tooth, and those 6 through 11 years of age average over four carious teeth. Among youths 12 years through 17 years old, more than six permanent teeth are decayed. Moreover, 39% of white and 66% of nonwhite individuals under 17 have never been to a dentist.

Dental caries is the localized, progressive destruction of a tooth by acid demineralization initiated at the surface. The tooth crown may become destroyed completely and the tooth pulp tissue and adjacent bone may become abscessed, cause acute pain, and necessitate extraction. In severe or rampant, uncontrolled caries, decayed front teeth present a disfiguring appearance.

Caries results from interaction among three factors: bacteria, a susceptible tooth, and the diet. In the caries process, specific bacteria on the tooth surface ferment dietary carbohydrates and produce acid that dissolves the tooth structure.

In 1971, the National Institute of Dental Research (NIDR) established the National Caries Program (NCP), an organized, targeted program designed to eliminate or significantly reduce dental caries as a public health problem. To achieve this goal, the NCP has pursued the research strategies listed below:

1. Combat the bacteria.
2. Increase the resistance of the tooth.
3. Modify the diet.
4. Improve the delivery and public acceptance of preventive measures.

During the past decade, significant progress has been made in all of these areas, but most notably in research strategy 2 where the public health application of topical fluoride has been highly successful. This measure appears to have already had a major impact on caries prevention in this country. According to recent Congressional testimony, this past decade has witnessed a reduction in decay of at least 25%. Meanwhile, research on the microbial etiology, the immune response, and on nutrition has yielded an impressive array of new information that may lead to a permanent solution for this disease.

Extensive microbiologic studies have shown that the principal organisms involved in dental caries (*Streptococcus mutans*) have several characteristics that implicate them especially in the production of decay. These bacteria not only produce acid by fermenting sugary foodstuffs, but they also synthesize a sticky substance that enables them to adhere to tooth surfaces and to localize high concentrations of acid. Furthermore, these organisms can themselves survive in a high acid environment and also can store sugars and use them to produce acid between feedings when no dietary sugar is available. To develop techniques to interfere with these processes, scientists have purified the enzymes used by the bacteria to synthesize the sticky material and injected these enzymes into rats as a vaccine; as a result, the rats made specific antibodies against the enzymes and tooth decay was reduced. In related studies, human volunteers have ingested capsules containing a vaccine of killed *S. mutans*. Such subjects produced antibodies in the saliva and were able to clear the mouth of *S. mutans* organisms more quickly than before vaccination. These results offer promise that an oral vaccine suitable for the prevention of human dental caries may be possible.

Since little more than half of the American people currently benefit from having the optimum amount of fluoride in their public water supplies, scientists have sought other ways of making fluoride available to those not receiving it. Dental scientists have applied fluoride to the teeth in gels or solutions and incorporated it into toothpastes, chewable tablets and rinsing solutions. In all these forms, the fluoride has been effective in preventing decay. U.S. Public Health Service investigators have achieved striking success with school programs in which children living in areas without water fluoridation performed weekly mouth rinsing with fluoride solutions under the supervision of school personnel. To show how successful this self-applied

measure can be and to foster expanded use of it, NIDR recently conducted a large-scale demonstration project involving 80,000 children in 256 schools throughout the U.S. Even before this highly successful project was completed, it became evident that the NIDR should promote the widespread application of preventive programs that include fluoride rinsing and fluoride tablets. This promotion consisted of exhibit showings at many meetings, the loan of educational films, the widespread distribution of leaflets on the mouth-rinsing procedure, and the distribution of 205,000 posters. Approximately 10 million school children now are receiving the benefits of the fluoride mouth-rinsing procedure, and another 2 million in nonfluoridated communities are receiving the benefits of fluoride tablets.

In another approach toward increasing the resistance of the tooth, scientists have focused on the pits and fissures of the chewing surfaces of the teeth. Fifty percent of the decay in posterior teeth involves these areas, which are not well protected by fluoride. Research during the early 1970s showed that these areas could be protected by coating them with a thin layer of plastic. Although this measure was successful in clinical trials, it requires trained personnel for application, and thus, is not as cost effective as self-applied fluorides. Therefore, the method was recommended as a procedure for the private dental office but its public health application was regarded as limited. However, several recent studies indicate that significant cost reductions may be possible and public health application of this technique is again under study.

In developing a basis for the prevention of tooth decay by modifying the diet, scientists have studied the cariogenicity of different types of food in animal models. Tests with a variety of sugar-containing foods confirmed that caries potential is correlated roughly with the amount and form of sugar in the food. It also was found, however, that the frequency of ingestion, or number of snacks per day, was more important than the amount of sugar in a snack food. Interestingly, some snack foods believed to have low cariogenicity actually caused significant decay in the animals, whereas others, such as cheddar cheese, seemed to exert a protective effect.

Dental materials research during the past decade has led to significant improvements in the treatment of decayed teeth and has reduced the incidence of recurrent decay around fillings. Today's silver amalgam fillings for posterior teeth serve better and last longer than those of a few years ago, and the new composite fillings for front teeth are greatly superior to the silicate fillings of earlier decades.

The dental caries studies summarized in this paper offer great promise that caries soon will be reduced to such a low level that it no longer will be considered a public health problem. Some scientists believe that this goal will be reached by the end of this century; others predict that the goal will be reached by the end of the present decade.

Malocclusion

Malocclusion is an oral condition in which improper positioning of the teeth and jaws prevents them from functioning well as a mechanical unit. Commonly manifest and best treated during childhood and adolescence, malocclusion includes such con-

ditions as a protruding upper or lower jaw; cross-bite of the back teeth; and malpositions of the teeth, such as outward displacement, rotation, or crowding and overlapping. All of these types can be equally disfiguring, depending upon severity. These conditions often become a functional and social handicap to the child and a financial handicap for the family. Treatment is often expensive and prolonged, but if it is not carried out, the eventual traumatic impact on the individual may be devastating. The prevalence of malocclusion among the 22 million youth and young adults in the United States is high. Approximately 29% (6.5 million) of U.S. youth 12 to 17 years of age have malocclusion that should be treated, and more than half of these are so severely handicapped that treatment is mandatory. Genetic factors and growth defects are believed to be primary etiologic influences, but a certain number of cases are acquired through habits, such as tongue thrusting or thumb sucking.

Research into the treatment of malocclusion has emphasized an understanding of facial growth. Advances have been made in discovering the timing of the biological events involved in growth and in predicting the structural relationships that will develop as a result of growth. Findings from these studies have helped clinical scientists to predict the growth patterns that might lead to malocclusion and to institute treatment at the most appropriate time.

Research based on engineering and biomechanical principles also has led to major advances in the design and development of orthodontic appliances. Efficient new materials have been produced, such as adhesives (instead of metal bands) to glue brackets to teeth, and improved orthodontic wires that exert gentle, long-acting forces. As a result of research to determine how surgery affects facial growth and to determine how stable the resulting tissue relationships are, clinicians now understand better the limitations and benefits of orthognathic surgery performed early in childhood. Orthognathic surgery is a combined surgical and orthodontic approach in which segments of the jaw are separated and repositioned to improve the way the jaws and teeth fit together and function. This treatment is performed only in severe cases of malocclusion. Current research on the use of removable appliances indicates that such appliances can be used to modify growth patterns and intercept certain malocclusions before they reach an extreme stage. This approach offers a relatively inexpensive alternative treatment for a small but significant number of patients. Basic research on how orthodontic forces actually produce tooth movement is also under way. Understanding what the chemical signals for movement are, and how they are transmitted, should enable scientists to devise more effective treatment in the future.

Cleft Lip and Palate

Clefts of the lip, or palate, or both constitute major birth defects that affect nearly 6,000 newborns each year in the U.S. The total number of individuals with clefts in the population exceeds 300,000. The incidence among live-born whites is believed to be greater than 1 in 600. Among American black infants the frequency is lower; but among Japanese, Chinese, Eskimos, and American Indians, it is substantially higher. Cleft lip and palate occur together more frequently than separately. Congenital in

origin, oral clefts always have a tremendous impact on the parents as well as the child. The palate is part of a system essential for respiration and feeding. If these functions are impaired by anomalies, the results can be life-threatening or detrimental to later development. If speech is affected, the child is handicapped in an extremely important, specifically human characteristic. If the cleft is untreated or treated poorly, the resulting facial disfigurement profoundly disturbs the parents, and, in time, the child. Therapy is extremely complex, because the child with a cleft poses an intertwined medical, dental, emotional, social, educational, and vocational problem requiring prolonged supervision for optimal habilitation.

Many factors are implicated in the etiology of cleft lip and palate. Heredity is a major factor, but such diverse influences as nutritional deficiencies, stress, infectious diseases, radiation, and drug ingestion during a critical period of pregnancy also may play a role. At the present time, prevention of oral and facial clefts is best accomplished through preconception counseling for those with a family history of clefts, or with offspring with clefts, and the avoidance during pregnancy of suspected etiologic factors.

Major advances in the management of children with oral clefts have been made during the past decade. Through multidisciplinary research and cooperative treatment by teams of practitioners and clinical investigators, a great deal has been learned about growth and function in children with clefts. Research of this type has improved our understanding of how surgical repair can interfere with normal facial growth. These studies have resulted in new and improved surgical techniques which preserve the normal growth potential, facilitate speech development and bring about an improved facial appearance. Patients treated by such techniques acquire a sense of self-esteem and go on to lead happy and productive lives. A considerable basic science effort now is being devoted to research on the causes of clefting and on the pathologic mechanisms responsible for it. Knowledge obtained from this research ultimately may allow us to improve our approach to prevention and treatment.

Accidents/Trauma

Trauma to the mouth and teeth of children is often the result of automobile collisions, child abuse, fighting, and sports activities (particularly football, hockey, boxing, and wrestling). The full extent of oral injuries resulting from accidents or trauma in this country is not known. In a recent Seattle study, however, it was found that dental injuries made up almost 8% of all school injuries and occurred at a rate of 2.3 per 1,000 children over a 180-day academic year. One of every two such injuries was considered serious. In Kansas schools, injuries to the teeth and mouth accounted for 5.6% of all injuries.

Although the incidence of oral injuries does not seem high, the sequelae and/or residual treatment needs may be long lasting and costly. The treatment of injuries requiring surgery has been improved by the research on growth and development and on experimental surgery referred to earlier in connection with cleft palate. Fractured or traumatically displaced teeth now can be treated by improved techniques, which employ new adhesive materials for repair and more effective methods

for root canal and reimplantation therapy. Prevention of injuries to the teeth during sports activities is being accomplished by the use of mouth protectors, which are mandatory in many contact sports where the risk of injury to the teetn is high.

Periodontal Disease

Periodontal diseases, diseases of the bone and connective tissue that hold the teeth firm in the jaws, are the major causes of tooth loss among adults in the U.S. More than 75% of adults are afflicted by periodontal disease, and one-third of these severely. In addition, more than 11% of the entire population have lost all of their natural teeth, primarily because of periodontal disease.

Young populations are affected primarily by gingivitis, or inflammation of the gums, a reversible condition. Gingivitis is evident in 14% of children 6 to 11 years of age and in 32% of youth 12 to 17 years of age. The prevalence of destructive disease in normal adolescents is estimated to be only 1%, although it is believed to be much higher in special groups, such as juvenile diabetics and children taking phenytoin (Dilantin) for neurological problems. Poor oral hygiene, which allows bacterial plaque to form and remain on the teeth, continues to be the single most important factor in the development and progression of periodontal disease.

Periodontal research of the past decade has shown that specific bacteria cause different types of periodontal disease and that the body's reactions to these bacteria may cause the tissue destruction. The white blood cells, which migrate to infected tissues and engulf the bacteria, are extremely important in combating these diseases. Such studies enhance our understanding of periodontal diseases and may lead to better prevention and treatment. For the present, however, prevention and control of this disease is accomplished best through daily removal of bacterial plaque and periodic professional care. Thus, if these practices are established firmly as a daily routine during childhood, it is likely that they will be continued in adulthood, and destructive periodontal disease will be avoided.

Oral Soft Tissue Diseases

The most frequent lesions observed in the oral soft tissues and lips of children are recurrent aphthous ulcers and herpes simplex virus infections. Oral cancer also deserves mention, because habits begun in youth may lead to this condition.

Recurrent aphthous ulcers, or canker sores, are painful, white ulcerations on the mucous membranes of the mouth. They range in severity from mild forms involving one or two lesions which heal in 2 to 10 days, to more severe necrotic ulcerations that are larger than one centimeter and persist for 2 weeks or longer. In its severe form, the condition causes continuous discomfort and seriously interferes with eating. The highest frequency of onset is during the second decade and the vast majority of patients becomes affected before age 30. A positive family history is common. The etiology is unknown in spite of extensive research over a long period. At present there are no clues to the etiology and little promise of a preventive measure. Palliative treatment appropriate for children includes only emollients and mild local anesthetics.

Herpes simplex virus Type I infections occur in 50% to 75% of the U.S. population, with most of the primary infections occurring before age 20. The most common problem is recurrent herpes labialis or the common cold sore, which affects over 90 million Americans each year. Occasionally, herpes simplex virus causes death or chronic eye infections leading to blindness, and it also is believed to be involved in the development of cancer. This virus persists in the body in a latent state in a nerve ganglion close to the site of initial infection. From time to time, the latent virus is stimulated to replicate and cause new cold sores or skin lesions by such conditions as sun exposure, trauma, illness or emotional stress. In an estimated 10% to 15% of very young children, the initial herpes infection is manifested as a gingivostomatitis characterized by multiple crops of painful ulcers throughout the mouth, fever, malaise and loss of appetite. Thereafter, recurrent lip infections may serve as the only evidence of the persistence of the virus within the body.

Presumably, as a result of the research establishing the chronic, latent nature of herpes simplex infections and research possibly linking the virus to cancer, herpes labialis infections now are looked upon with greater concern than in earlier decades. It is known now that the localized oral lesion is only one part of a complicated systemic host/parasite relation that may involve many cycles of infection in different tissues. Since infection with herpes simplex appears to be very widespread and can have serious consequences, effective preventive and therapeutic measures are needed badly. Prospective approaches to the control and prevention of these infections include specific vaccination, chemotherapy, and interferon.

Oral cancer: Each year more than 24,000 new cases of oral cancer occur, and more than 8,000 deaths result. This condition is strongly associated with the prolonged heavy use of tobacco and alcohol. Although oral cancer is rare in children and young adults, the behaviors linked with its development frequently begin in adolescence and persist throughout life. Thus, preventive programs for the young should include effective health education on the long-term effects of tobacco, alcohol and other potentially hazardous substances.

Cost of Dental Care

The national dental bill for 1980 was 14.7 billion dollars, even though only part of the U.S. population received treatment. An analysis of 1978 data showed that nearly all of the expenditures for dentists' services that year ($13.3 billion) were borne by the patients themselves: 77% was paid directly to dentists by patients, and 19% was paid indirectly through various private third party plans; government funds covered only 4% of the bill. In contrast, 42% of the cost of all other health care was paid for with public funds. Although the portion of the population covered by third party dental programs continues to increase, large numbers of Americans remain untreated. However, cost is not the only consideration that prevents individuals from obtaining care. Some of the other factors to consider include the individual's education, ethnic background, income, fear and anxiety regarding dental treatment, as well as the availability of health providers.

Summary

Oral disorders affecting children include dental caries, malocclusion, cleft lip and/or palate, traumatic injuries, periodontal diseases, and oral ulcerations. Because these diseases also can be detrimental to the mental well-being of the individual, they can, and often do, inhibit social development. Since the oral health status of the adult is determined by childhood experiences, children should be taught the value of prevention and prompt treatment of oral diseases. Research progress also must be maintained.

Dental caries affects more than 95% of youth over 12 years of age, with those in the 12- to 17-year-old range averaging more than six decayed permanent teeth. In the caries process, bacteria ferment dietary sugars and produce acids that dissolve the tooth. Research, therefore, is based on the following strategies: combat the bacteria, increase tooth resistance, modify the diet, and improve the delivery and acceptance of preventive methods. Scientists have identified the principal causative organisms (*Streptococcus mutans*), and shown how they cause decay. Moreover, they recently purified an enzyme from these bacteria and injected it into rats as a vaccine; as a result, the animals had less tooth decay. Human volunteers who had ingested a capsule containing *S. mutans* produced antibodies in the saliva and were able to clear the organism from their mouths faster than before vaccination.

Since only half of the U.S. population benefits from having the optimum amount of fluoride in their drinking water, scientists from the National Institute of Dental Research (NIDR) have sought additional ways of making fluoride available. After first showing that school programs involving weekly mouth rinsing were effective, they initiated a large-scale demonstration project in 256 schools. Subsequently, the NIDR promoted this approach and other school-based fluoride preventive measures. Twelve million children are now obtaining the benefits of these preventive programs. During the past decade, tooth decay in the U.S. has been reduced by at least 25%.

Since the chewing surfaces of the teeth are not as well protected against decay by fluoride as are the others, scientists developed a method of coating them with plastic. Because this method was not cost effective as a public health measure, it was recommended only for use by private dentists. In developing a basis for the prevention of tooth decay by modifying the diet, scientists have studied the cariogenicity of different kinds of food in animal models. These studies showed that the number of feedings per day was more important than the amount of sugar in the food.

The term, "malocclusion," includes protruding upper or lower jaw, cross-bite, and such malpositions of the teeth as outward displacement, rotation, or crowding and overlapping. These conditions often become a functional and social handicap to the child and a financial burden for the family. In the U.S., 29% (6.5 million) of the 22 million youths 12 to 17 years of age have malocclusion that requires treatment. Causes include genetic factors, growth defects, and habits, like tongue thrusting and thumb sucking. Research has emphasized facial growth patterns primarily, but also has achieved improvements in the design of orthodontic appliances and materials.

Clefting of the lip or palate occurs in 6,000 newborn infants each year in the U.S. The affected child usually presents a complex medical, dental, emotional, social, educational, and vocational problem. Etiologic factors include heredity and such environmental influences as nutritional deficiencies, stress, infectious diseases, X-irradiation, and drug ingestion during pregnancy. Prevention is accomplished through preconception counseling for those with a positive family history and the avoidance of suspected etiologic factors during pregnancy. Research has resulted in improved surgical techniques that enable cleft children to achieve normal growth, speech development and improved appearance.

Damage to the mouth and teeth often result from automobile collisions, child abuse, fighting, and contact sports activities. In a recent study, dental injuries made up almost 8% of all school injuries.

Periodontal diseases, which affect the tissues supporting the teeth, attack more than 75% of adults and are the major causes of tooth loss in adults in the U.S. Young persons are affected mainly by gingivitis, a reversible condition. Since research has shown that bacterial plaque causes the disease, children should be taught to practice daily oral hygiene as a lifetime routine.

Recurrent aphthous ulcers, or canker sores, are painful, persistent mouth ulcerations that occur in children as well as adults. The etiology is unknown and treatment is palliative only.

Primary herpes simplex virus Type I infections occur in 50% to 75% of the U.S. population, usually before age 20. The most frequent problem is the common recurrent cold sore. This virus persists in a latent state in a nerve ganglion, and from time to time, is stimulated to cause new cold sores by such conditions as sun exposure, trauma, illness or emotional stress. Since infection with herpes simplex is widespread and can have serious consequences, preventive measures are needed badly. Prospective approaches include vaccination, chemotherapy, and interferon.

Although oral cancer is rare in children and youth, it is linked to behavior patterns begun in adolescence. Thus, preventive programs should include education on the long-term effects of tobacco and alcohol.

The cost of dental care in the U.S. is nearly 15 billion dollars per year, but many citizens still do not receive treatment, because of the cost, the patient's level of education, fear and anxiety regarding dental care as well as the availability of health providers.

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